Essential Patents and Coordination Mechanisms

Justus Baron, Tim Pohlmann

CERNA WORKING PAPER SERIES

Essential Patents and Coordination Mechanisms

The effects of patent pools and industry consortia on the interplay between patents and technological standards

Justus Baron & Tim Pohlmann

Working Paper 2010-13

Cerna, Centre d'économie industrielle
MINES ParisTech
60, boulevard Saint Michel
75272 Paris Cedex 06 – France
Tél. : 33 (1) 40 51 90 00

July 2010

Essential Patents and Coordination Mechanisms

The effects of patent pools and industry consortia on the interplay between patents and technological standards

Justus BARON[1]
Tim POHLMANN[2]

Abstract

This article investigates the interplay between formal standards, essential patents and informal industry alliances such as consortia and patent pools. Building upon more than 6.200 declarations of essential patents to major international Standard Development Organizations (SDO), we investigate how informal standardization consortia and patent pools influence the number and timing of patent declarations to formal SDOs. This is the first thorough empirical investigation of the effectiveness of industry-driven coordination mechanisms addressing the problems raised by the high number of patents. We find that patent pools increase the number of declared essential patents controlling for the effects of standardization. On the other hand, informal consortia reduce the number of patent declarations at given standardization activity. These findings confirm results in the literature that patent pools provide incentives for strategic patent files and that informal standardization consortia have a regulatory function on the firms' patent strategies.

[1] Cerna, Mines ParisTech
[2] Berlin University of Technology, Chair of Innovation Economics

INTRODUCTION

Over the last ten years, the interplay between patents and technological standards has attracted increasing attention in the academic literature and among policy makers. Recent policy efforts rely upon the view that providing for reliable and economically sensitive rules on Intellectual Property Rights (IPR) in standardization is necessary for a "digital society"[3] and beneficial for innovation[4]. On a different stance, it is perceived that the failure to address these issues would threaten competition and increase the risk of anticompetitive strategies[5]. In parallel to these policy efforts, standardizing firms have themselves come up with coordination mechanisms in order to improve the interplay between patents and standards. Probably the most important mechanisms accompanying formal standardization are industry consortia and patent pools. It is the aim of this paper to study the effect of these industry-driven mechanisms, and more particularly to analyze their impact on the number of patents declared essential to formal technology standards.

Two developments are the probable trigger for the recent interest in patents essential to technological standards: In the first place, the rise of the information and communication society strongly relies on interoperability of technologies, making common standards indispensable. As a result, not only the quantity but also the importance of standards strongly increased during the last decades (Blind & Gauch, 2008). Secondly, accompanying this development is the growing importance of Intellectual Property Rights (IPR), mainly patents, which are essential to widely adopted standards (Bekkers et al., 2001). A patent is called essential for a standard when it is necessarily infringed by any implementation of the standard. Technological standards are increasingly complex and incorporate sophisticated technology resulting from costly firm R&D. The inclusion of technology protected by patents has proven to be necessary for an increasing number of important technological standards.

Even though both the patent and the standard system are important institutions shaping technology-intensive network industries, their interplay has often been viewed with suspicion. It is a widely shared belief that patents or other IPR are a necessary incentive for companies to innovate. Nevertheless, in network industries and other sectors where innovations are cumulative and many innovating firms build upon the research of each other, the role of patents is more ambiguous. As

---

[3] Digital Agenda for Europe 2010-2020. See http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52010DC0245:EN:NOT

[4] European Commission White Paper "Modernising ICT standardization: The way forward". The White Paper can be consulted at http://ec.europa.eu/enterprise/newsroom/cf/itemlongdetail.cfm?lang=fr&item_id=3263

[5] Draft Communication of the European Commission „Guidelines on the applicability of Article 101 of the Treaty on the Functioning of theEuropean Union to horizontal co-operation agreements"; http://ec.europa.eu/competition/consultations/2010_horizontals/guidelines_en.pdf

patents confer the right to exclude others from the use of the technology, they allow holders of complementary patents to block each other. Problems of blocking patents on a standard can result in high transaction costs, prohibitive costs for products implementing a standard and slow diffusion of new technologies. These problems have been labeled as "tragedy of the anticommons" (Heller and Eisenberg, 1998).

A further aspect to the interplay between patents and standards is that inclusion into a standard may increase the commercial value of a patent for its holder (Rysman and Simcoe, 2006, Bekkers et al. 2001). Standardization thus generates additional incentives for strategic firm behavior regarding their patent portfolios. In some cases, strategic behaviors regarding essential patents have led to contentions. Especially the litigation cases involving Rambus and Qualcomm raised the attention of antitrust authorities and reinforced the political discussion about IP regulations concerning standards (Hovenkamp, 2008; Bensen & Levinson, 2009; Devlin, 2009).

In spite of this increased awareness of the importance of essential patents for standard setting, there has been so far little research on the effectiveness of possible solutions and regulation mechanisms. Intellectual Property rules of standard setting organizations are becoming increasingly important in regulating the market (Lemley, 2002). Shurmer and Lea urged in 1995 that IPR on standards is a topic of public interest and that the potential problems need to be discussed on an international level. In Europe, the European Commission has recently taken several initiatives in order to provide SDOs with an improved policy framework and avoiding that problems of essential patents slow down or deteriorate the outcomes of standardization[6].

In parallel to the advances in the regulatory framework, firm-driven regulation mechanisms have emerged in industries where standard setting is most crucial and where essential patents are most likely to give rise to contentions. Industry consortia and other informal firm alliances evolve around formal standardization projects. Many industry consortia are themselves active in standardization and help overcoming blockings in the standardization process resulting from burdensome and lengthy procedures in the formal bodies. More generally, many consortia and alliances provide a forum for firms involved in standardization to discuss policy issues and to settle contentions on essential IPR.

Another promising instrument in clearing blocking positions arising from essential patents held by various owners is the creation of patent pools. A patent pool is an arrangement for offering joint licenses for the patents of pool members to third parties. The licensing revenue is redistributed to the owners of the patents. Patent pools can significantly reduce transaction costs encourage rapid

[6] See notes 3, 4, and 5

implementation of technological standards. Nevertheless, patent pools as any price fixing mechanism have the potential to distort or reduce competition and must therefore meet concrete standards regarding their licensing policies and setting[7]. Furthermore, redistribution of royalty income is a contentious issue. Most pools redistribute royalties according to the shares of patents held by the various pool members. Such royalty distribution schemes provide further incentives for filing many patents; so that patent pools could themselves contribute to the patent thicket they are designed to clear.

This article will explore the effect of patent pools and industry consortia on the interplay between standards and patents in greater detail. We will analyze the timing of patent declarations with respect to standardization, and study the correlation between standard characteristics and the number of patents declared essential. We will then analyze how this interplay is affected by industry consortia and patent pools. The remainder of this article is organized as follows: Section 1 reviews the literature and works out the research hypotheses. Section 2 outlines our methodology and describes the construction of the data set. Section 3 discusses descriptive results, and section 4 presents the results of analytical investigation. Section 5 sketches the outline for future research and concludes.

THEORETICAL BACKGROUND AND RELEVANCE OF INVESTIGATION

Several articles have explored the issue how standardization affects the motives of companies to file patents. Blind et al. (2006) find that taking influence on standardization is not one of the main incentives to patent. It has furthermore been found that companies with a high patent intensity are less likely to participate in standardization (Blind & Thumm, 2004). On the other hand, Koehler et al. (2010) identified a strategic patent filing behavior for essential patents. The latter analysis revealed that patents which are essential to a standard are pending significantly longer than the ones in the control group. These results indicate a strategic adjustment of patents in order to make sure that the protected technology is essential to the standard. Evidence for strategies to file patents such as to cover standard-essential technology has also been found in other analyses. Layne-Farrar (2008) revealed that ex post patents are of less value than ex ante patents as to a standard release, which is a further indicator of strategic and opportunistic patent behavior.

Strategic considerations can affect not only the choice of companies to file patents on standard-essential technology, but also the choice to disclose and declare existing patents as essential. Layne-Farrar (2010) furthermore reveals that in contradiction with common perception most patents are

[7] See J. Lerner and J. Tirole (2004) and D. Quint (2006)

declared essential well after the standard is released. These widely practiced declaration strategies can nevertheless be thought of as detrimental, since Bensen & Levinson (2009) remark that ex ante disclosures and ex ante agreed license fees would more likely increase incentive of companies to invest in R&D.

The literature thus indicates that standard setting has an impact on the decisions of firms to file and declare patents protecting technology included into the standard. This might in some cases allow opportunistic behavior. Nevertheless, the standardization process itself is not alone in determining the patent filing and disclosing behaviors, as other determinants come into play. Most importantly, the analysis needs to take into account firm alliances such informal standard consortia and patent pools that are connected to a formal standard.

Informal consortia are very heterogeneous in characteristics such as technical issues, structure, members, transparency or IP policies (Cargill, 2002; Pohlmann, 2010). Updegrove (2008) defines consortia as being "anything from a loose, unincorporated affiliation of companies, to an incorporated entity with offices, marketing, technical and administrative staff and a multi-million dollar budget". Especially the treatment of IPR protected standards and the influence to formal standard setting were subject to evaluations of the role of informal consortia. Leiponen (2008) revealed that participation in informal consortia improves the participation in formal standardization when analyzing the case of the ETSI 3GPP committee. Blind and Gauch (2008) identified a complementary relationship of formal and informal standardization on the technical layer and revealed a positive correlation between formal and informal standardization activities. Rysman and Simcoe (2007) support a political interest in informal consortia, as they can function as an important technology selector. Even though Devlin (2009) explains failures of IPR treatments in consortia, he proposes solutions how informal consortia might act as royalty regulators ex ante – before the industry has incurred substantial sunk cost in implementing the standardized technology.

The empirical findings in the literature clearly indicate that informal consortia can be complementary rather than alternative to formal standardization. Informal consortium activity can play an important role for formal standard setting in coordinating firm strategies in the implementation of the standard. For instance, informal consortia can play a role in coordinating applied R&D necessary to implement the objectives set out by a formal technological standard. This would result in lower costs, as the duplication of R&D efforts is avoided. Furthermore, informal consortia can play the role of a forum where firms agree on common rules to avoid inefficient non-cooperative behaviors. A high propensity to patent can be an outcome of inefficient non-cooperative firm strategies, when each firm tries to build up an important patent portfolio in order to gain bargaining power with respect to other industry players or reap important shares of licensing

revenue from patent pools (Parchomowsky and Wagner, 2005). In both cases, consortia would increase efficiency by reducing the number of essential patents at given standardization activity. Therefore we propose Hypothesis I:

H1: The existence of an informal consortium, controlling for standardization activity and standard size, reduces the number of patents declared essential for a formal standard.

A second external factor which might influence a patent declaration is the existence of a patent pool. Even though a patent pool has no connection to standardization processes, patents that protect a standard are often incorporated in a patent pool. Contrary to most economic assumptions that pool participation is automatic, Farrar and Lerner (2008) show that companies decide joining a pool depending on the pursued profit sharing rule. They furthermore reveal that entering a pool may allow the firms to include patents of a limited economic value. Baron and Delcamp (2010) find evidence for the strategic inclusion of low quality patents into pools. Especially earlier pool members are able to include more patents and patents of lower quality into a pool, compared to new members. Since being an initial pool member might create first mover advantages, Lampe and Moser (2009) revealed strategic patent filing, when a pool creation was expected.

Including patents in a pool might also improve the value of a patent, as Delcamp (2010) showed that pool patents are cited more often not only because pools tend to select high quality patents, but also because the introduction of a patent into a pool induces an increase in the number of citations. Gilbert (2009) however created a model that reveals a greater royalty stream for independent licensors outside a pool. Consistently with this prediction, Lampe and Moser (2009) find that a patent pool increases the incentives to file patents not only for pool members, but also for companies holding complementary patents staying outside the pool.

Empirical and theoretical literature indicates a positive effect on the number patent files when a pool is created both for pool members and companies staying outside. Hence, we propose Hypothesis II:

H2: The existence of a patent pool, controlling for standardization activity and standard size, increases the number of patents declared essential for a formal standard.

METHODOLOGY

We test the aforementioned hypotheses empirically using an extensive database. Unlike the existing literature, our research jointly takes information on formal standardization, informal consortia and patent pools into account in determining the driving factors of patent declarations. Thus we are able to identify and isolate the effects of each of these institutions on the number of patent declarations.

Comparing firm's contribution to different standards is always difficult, as unobservable factors such as technological characteristics or the commercial relevance of the standardization project crucially impact patent declarations and other firm decisions. We will use longitudinal data and panel methodology in order to rule out that unobservable factors bias our results. Therefore we undertook extensive work on the data in order to inform all relevant variables over a time span from 1992 to 2010. To ensure a clear and reasonable distinction of different standards, our analysis only focuses on formal standard developing organizations (SDO) which operate on an international level. Our data includes standards from ISO, IEC, JTC1 – a joint committee of ISO and IEC – CEN/CENELEC, ITU and IEEE. However, the latter two organizations are in some earlier literature considered as being informal (Rysman & Simcoe, 2007). We identified them as formal because standardization procedures, IP policies and organizational structures are conform with the formal standard bodies. This classification also finds support in several literature sources (Iversen, 2002; Leiponen, 2008; Blind & Gauch, 2008). As all these institutions practice the same IPR policy, we can rule out that institutional factors affect the comparability between standards in our sample.

Focusing on formal SDOs has the advantage that we can use a normalized unit of analysis, the standard. By contrast, the output of informal standardization can come in very detailed technical specifications or highly aggregated standardization projects. Furthermore all standards of these organizations are included in the PERINORM database, which insures a comparable understanding of a standard unit. PERINORM is the world's biggest database with bibliographic information on formal standards and is regularly updated by the SDOs DIN, BSI and AFNOR. From PERINORM,

As our analysis focuses on the interplay between standards and patents, we only take into account standards for which at least one patent has been declared essential. In order to avoid any selection bias, we use all patent statements made to the most important SDOs which are stated above.[8]

More than 6.200 patent declarations were retrieved in March 2010 from the patent statements available at the websites of the aforementioned formal SDOs. Each SDO has a separate patent statement data base, where the disclosing company has to state the formal standard identification number, the date of registration and the patents affected. We labeled each patent declared essential to each standard as one declaration. For example a patent statement for two patents declared essential to two different standards is counted as four declarations. Empty or so-called blanket

[8] Declarations to ETSI are not included in our analysis, since they refer to technical specifications or standard projects, which are not comparable to a formal standard and thus cannot be categorized due to data conformity. ETSI is is a special case, and stands for over 90 % of the patent declarations on formal standards. In the following, all our results refer to formal SDOs excluding ETSI. Generalizing our results to include semi-formal and informal standard setting will be one of our next working steps.

patent statements - i.e. statements of ownership of essential IPR that do not provide patent numbers - were also counted as one declaration. Counting separately individual patents that are declared together in one statement and taking into account blanket statements means that we have a "maximal interpretation" of the patent databases. For this reason, our number of declarations is higher than the number of patents used in other research projects that focus on the same SDOs (Bekkers and Martinelli, 2010).

The count of IPR declarations is only an approximation of the valid patents that are essential for a standard. Firms declare IPR they believe to be essential, but no objective evaluation of this claim is made. It might therefore be the case that many of the declarations relate to patents that are not really essential to the standard. On the other hand, even though some SDOs oblige firms participating in standardization to declare their essential IPR, it cannot be guaranteed that all essential patents are accurately declared. As firms participating in standardization are often large corporations owning big patent portfolios, it is possible that firms do not declare their essential patents because they were not aware of their existence. More generally, using patent statement databases does not allow us to disentangle the effects of explanatory variables on patent filing and patent declaration strategies. In spite of these limitations, we believe that the count of patent declarations is a valid indicator of the patent intensity of a standard. The decision to declare an existing patent as essential for a standard and the decision to file a new patent on technology included into a standard are clearly different, but both are probably driven by the same factors determining the profitability of essential patents.

A match of the different patent statements identified 647 distinct standards, where some standards were accredited in more than one SDO. If that was the case, the SDO of first release was the selected reference. Most of the statements were made within the last twenty years and thus the data panel includes all half year periods between 1992 and 2010.

We matched 647 formal standards to PERINORM, where we obtain information on standardization activities and characteristic such as standard release, version release, standard amendment, technological class or number of standard pages.

The formal standards are wherever possible linked to informal industry alliances arising around standardization. In particular, we use data from the 15 editions of the CEN survey of ICT consortia, identifying 453 informal consortia since 1998. Since there is no commonly accepted definition of informal standards consortia, our consortia database only includes organizations that meet the following selection criteria stated by the CEN survey: "The organization must be international in outlook and scope, not simply an instrument of single-nation policy, must have an active and international membership, must not be set-up specifically as a single vendor, government, or proprietary technology advocacy group and must be of importance to the areas of standardization or

its processes"[9]. The existence of a consortium does not always imply a contribution to standards setting. Therefore we used the date of first mention in the CEN survey as the first date of existence. For each consortium we thus label "consortium activity" the period during which the above stated criteria are met.

We further identify 43 existing patent pools and 11 failed attempts to create a patent pool. Several consortia and patent pools can directly be related to formal standardization projects. For example the MPEG4 Industry Forum is an informal consortium accompanying the formal standardization of MPEG4 standards in JTC1, and the MPEG4 Visual Patent Pool managed by MPEGLA, which is a patent pool offering licenses needed for implementing the MPEG4 visual standard. Proceeding this way, 115 standards in our sample can be related to an industry consortium and 39 standards to at least one patent pool.

The relation of a formal standard to an informal consortium is not always as obvious as to a patent pool and has to be explained in more detail. The matching was solely conducted on the standard level. A match of essential patents was not perused since our observation also includes empty declarations. Most informal consortia such as MPEG4, ECMA or IETF have official liaison statements for the respective formal standards. A liaison implies an accreditation and a cooperative standardization development between the formal and informal standards bodies. If an official statement was not given, a more detailed analysis of the respective standards was conducted. Consortia standards that include or build up on formal standards that matched our database were therefore included. A list of all informal consortia that matched our database can be found in the annex. In total 45 different informal consortia could be related to 115 formal standards that include essential patents. The interplay of informal and formal standard setting is very complex and the concrete repartition of tasks cannot always be identified. Liaisons are in many cases simultaneous processes where the formal committee works in close cooperation with an informal consortium.

We have thus produced a comprehensive database covering the quasi-totality of formal technological standards for which there is at least one essential patent. For all these standards we inform variables on three different layers of analysis: on the IP layer, we have information on the disclosing firms and on the disclosures, on the technology layer, we have detailed information on the technological characteristics of the standard and on standardization activity, and on the industry layer we make use of comprehensive data on standardization consortia and patent pools. As all information is given in longitudinal data, we can run fixed effect panel estimations to exclude obvious biases due to unobserved effects.

[9] CEN/ISSS 2009, page 10

DESCRIPTION OF THE DATABASE

Table 1 illustrates the number of standards that include essential IPR by SDO and the mean number of declarations per standard.

Table1. By SDO: number of standards with at least one patent statement / mean declarations per standard

SDO	Standards including patents (share)	Mean, declarations per standard
JTC1	109 (16.74%)	18.33
ITU-T	290 (44.55%)	7.01
ISO	91 (13.98%)	2.70
IEEE	79 (12.14%)	23.41
IEC	63 (9.68%)	1.38
CEN-CENELEC	19 (2.92%)	1.05

Table 1 shows that ITU-T has the biggest share of standards including IPR, making almost 45% of all regarded standards of the sample. On the other hand, most patents per standards can be found for IEEE, where companies in average state 23.41 declarations. Comparing the total number of declaration per SDO reveals that JTC1, IEEE and ITU-T each report more than 2000 declarations since 1992 and thus jointly stand for almost 95% of all patent declarations in the sample.

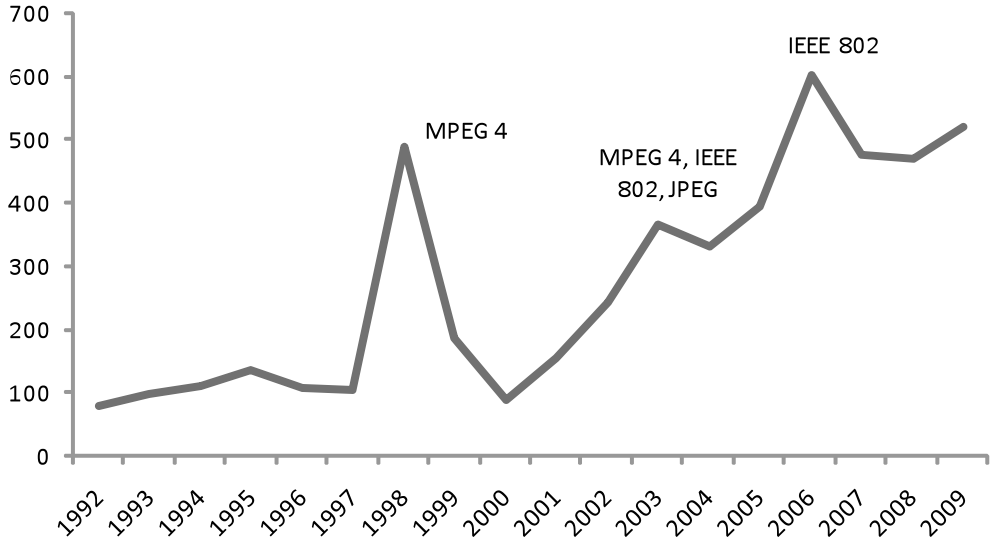
To better estimate the technological layer, all standards were categorized by the international standard classification number (ICS). Table 2 outlines the technological classes of the standards with at least one patent. The standard classes 33, 35, 37 can be summarized as information and communication technologies (ICT), which sum a share of more than 86% of all standards in the sample. Again changing from the standards to the patent perspective reveals that ICT standards have the highest average share of patent declarations. In total 98% of all declarations were made for ICT standards. This underlines the relevance for patents in this technological field.

Table2: By ICS: number of standards with at least one patent statement / mean declarations per standard

ICS	Number of Standards including patents	Mean, declarations per standard
03: Services	4 (0.71%)	4,25
25: Manufacturing Engineering	26 (4.63%)	1,85
29: Electrical Engineering	5 (0.89%)	1,2
31: Electronics	12 (2.14%)	1,67
33: Telecommunications.	262 (46.7%)	8,21
35: Information Technology.	222 (39.57%)	15,9
37: Image Technology	5 (0.89%)	10,6
43: Road Vehicle Engineering	7 (1.25%)	1,57
49: Aircraft / Space Vehicle	9 (1.6%)	1,11
97: Household / Commercial Equipment.	9 (1.6%)	1

To better measure how many standards include essential IPR in a general standard picture, the constructed panel was compared to all standards without IPR in the respective standard bodies, in each time period and only including ICT standards (classes: 33, 35 and 37). The analysis reveals a rise in the number of active ICT standards, as standards without IPR increased by almost 30% over the last ten years (excluding year 2010) and the standards including IPR increased by almost 150% (excluding year 2010). The share of standards including IPR increased from 0.21% in 1992 to 6.17% in 2010. Since not all patent declarations are made before a standard release, the truncation effect has to be kept in mind, which would even increase the share of standards that include IPR. The development during the last two decades underlines the growing importance of standards that include essential patents. However, the outcome of further statistical results has to be restricted to a sample of 6.17% of all ICT standards and thus only represents standards including essential patents. Graph 1 displays all declarations on standards each year in a time period from 1992 to 2009. The data panel shows that the distribution of patents on standards is in some cases concentrated on a certain standard project. Therefore the graph illustrates the top standard projects in peak periods that have the highest share of declarations.

Graph1: Declarations per year and peak standard projects

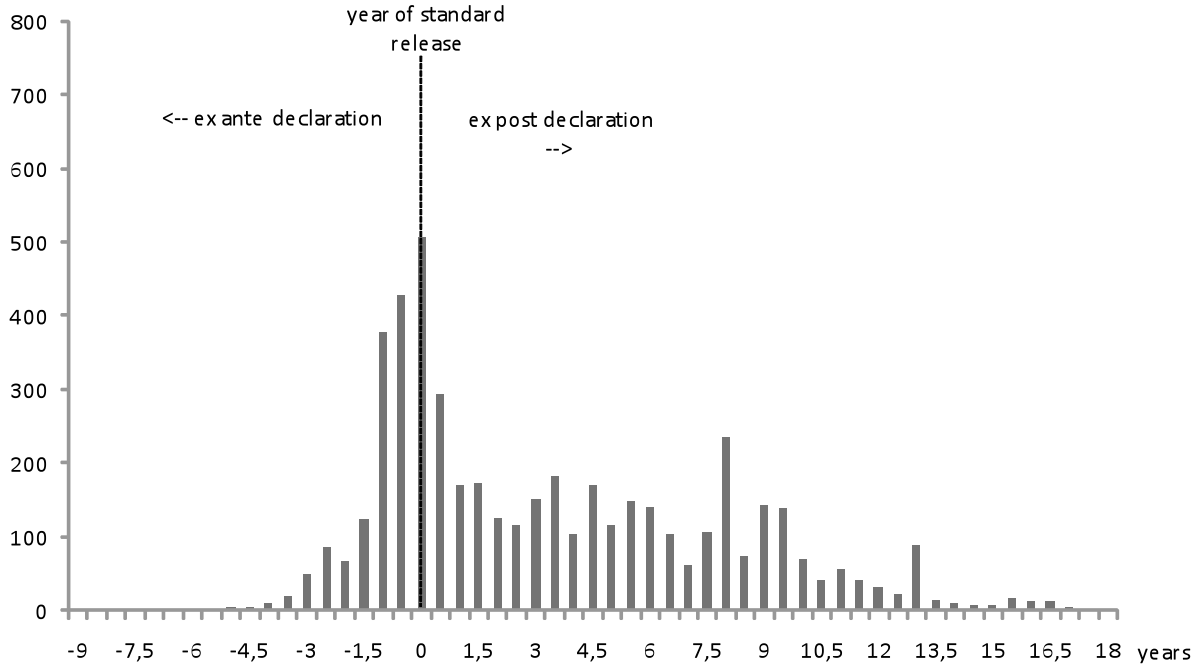


The first peak is in 1998 where the MPEG4 (Moving Picture Experts Group) standards ISO/IEC14496 (JTC1) sum over 45% of all declarations. The next peak in 2003 is also caused by the MPEG4 declarations but also by the IEEE 802 LAN (Local Area Network) project and the JPEG (Joint Photographic Experts Group) standards of JTC1 which all together sum around 43% of all declarations. The last peak is again caused by the IEEE 802 standard that alone sums over 55% of all declarations.

DESCRIPTIVE ANALYSIS

To support our research question we firstly want to identify the influencing factors of patent declarations on a descriptive basis. The constructed data panel allows an evaluation of the timing of patent declarations. Most intellectual property policies of the formal standard bodies require a complete patent disclosure of all companies that own relevant patents, before the standard is released. A disclosure is a statement to the respective working group or commission in a very early stage of standardization, before any official documents are released. A declaration in comparison is a public statement to the SDO which can be recognized by everyone, not only by internal commissions or working groups. While a disclosure seems to be vaguer and tends to show all possible affected technologies, a declaration is stated in a later phase of standardization and is thus more tangible and convincing.

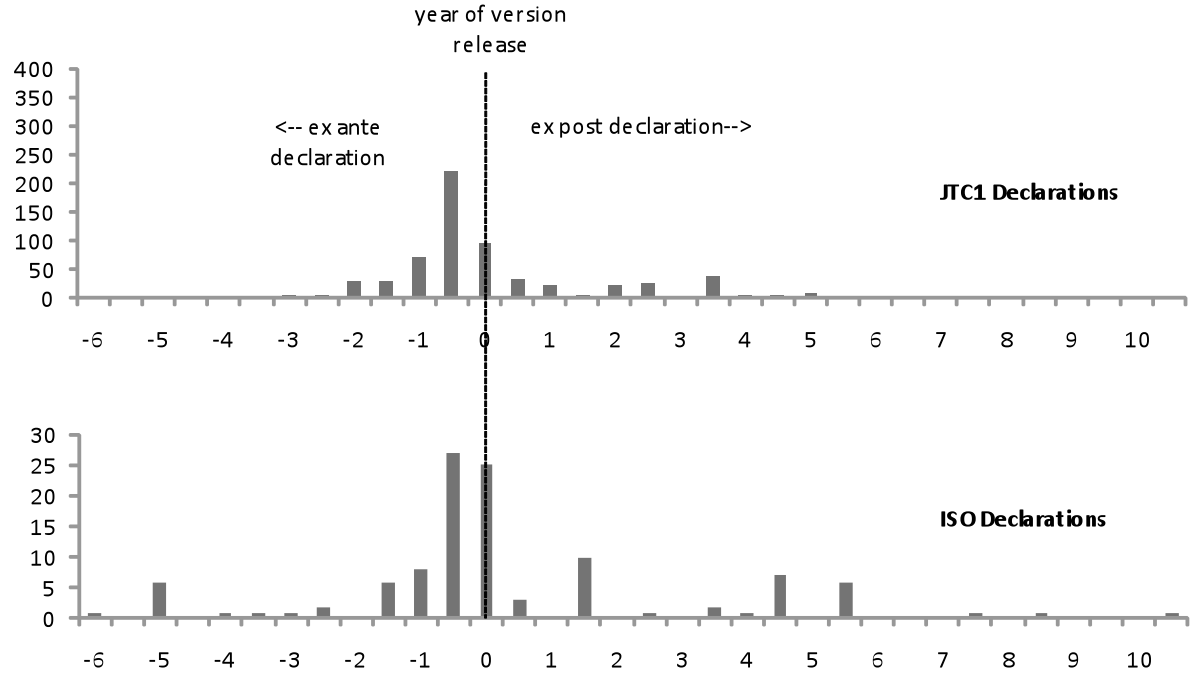
Graph2: Timing of patent declaration by the reference date of standard release



The preceding graph 2 shows the timing of patent declarations as measured by our declaration count with respect to the first release of the respective standard. Taking all declarations to the reference of the date of standard release, graph 2 illustrates the timing of declaration. 56% of all declarations are made later than one year after the first standard version is officially released. Slightly less than 35% of all declarations are stated ex ante or in the year of standard release.

Since a standard develops over time and thus may have new releases of versions, a more detailed estimation of the data is necessary. Only the ISO and JTC1 patent statements indicate the referred version and are matched in graph 3 for JTC1 and ISO. Using the version reference changes the picture for the JTC1 declarations where only around 20% of all declarations are stated one year or later than the version release. A share of 27% of all declarations was stated more than one year after the version release at ISO.

Graph3: Timing of declaration by reference version release for JTC1 and ISO standards

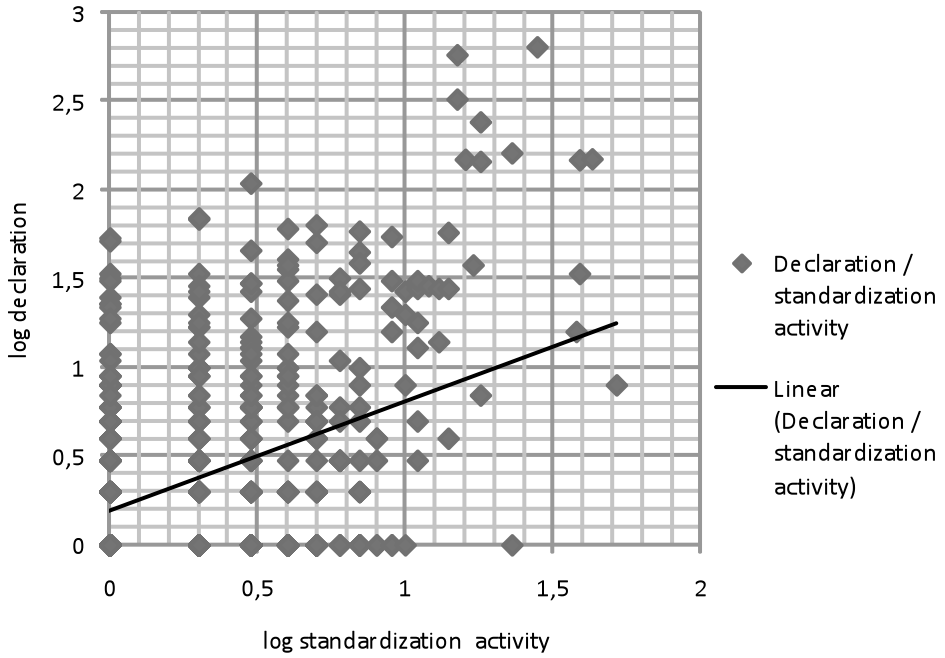


These results show that a new version may also include new technologies and thus new patents that protect these technologies. However, one fourth of the declarations are still stated ex post. In conformity with the results of Layne-Farrar (2010), who analyzed ETSI disclosures and found that only 5.2 % are state ex ante, we reveal that a significant share of declarations are made in a way that seems disconnected from the standardization process. These results justify our research investigation on the effects of industry coordination mechanisms on the number of patent declarations.

In addition to the release of a standard or a new standard version, there is also the possibility to agree on a standard amendment: "An amendment alters and/or adds to previously agreed technical provisions in an existing International Standard" (ISO/IEC, 2009). Since an amendment has the same committee agreement procedures as a standard release, we created a variable in our data panel called "standardization activity" that summarized all releases of versions and amendments. Graph 4 displays the relationship of declarations and standardization activity in a scatter box. Data was transformed to a logarithmic scale to reduce the results to a manageable range and show a more vivid picture. The logarithmic transformation also explains the high number of zero values, since there is a high amount of standards that only have one release or only one declaration. However,

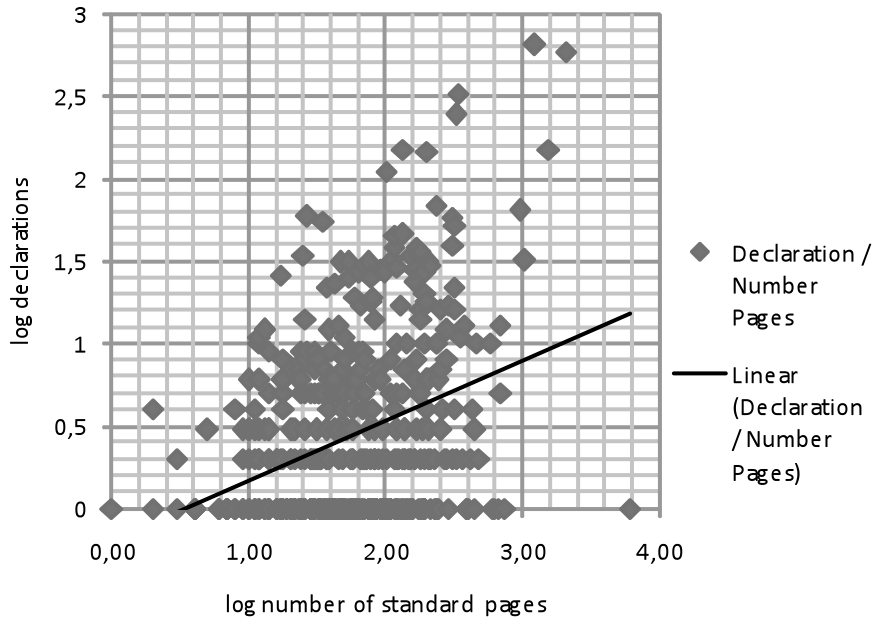
graph 4 already indicates a positive relationship between patent declarations and standardization activities.

Graph4: Scatter box of patent declarations and standardization activity on a logarithmic scale



Another hypothesis is to verify that the size of the standard has an influence on a patent declaration. Therefore we extracted the number of pages for each observed standard from the PERINORM database. Graph 5 reveals that there is a positive effect between patent declarations and the number of standard pages. Thus we can evidence a size effect; the bigger a standard the more patents are declared. Both descriptive results call for a deeper statistical analysis to better control these two effects.

Graph 5: Scatter box of declarations and standard pages on a logarithmic scale



Our first descriptive results of the declaration patterns already indicate that our declaration count is a meaningful measure of an economic reality that is closely linked to the timing and importance of a standardization project. Nevertheless, we also find evidence that the activity and the characteristics of a standard itself might not be the only factors that can influence a patent declaration. We were able to match the existence of informal standards consortia and patent pools to our panel of formal standards, to test external factors of declarations.

Table 3 clearly shows that standards that can be connected to a pool or an informal consortium have a much higher average number of declarations. These standards also have on average a higher number of pages, more releases and are more often amended. Furthermore, there seems to be a link between pools and consortia: indeed, out of 39 standards that can be linked to a pool, 31 can also be linked to a consortium (out of the 628 standards for which there is no pool, only 84 can be linked to a consortium).

Table3: Average number of declarations per standard

Sample	Mean
all standards	9.57
standards connected to a pool	96.04
standards not connected to a pool	6.41
standards connected to a consortium	15.13
standards not connected to a consortium	4.16

Taking into account the positive correlation between standard consortia and patent pools as well as between both these instruments and the number of declarations, standardization activity and number of pages, the effect of consortia or pools on patent declarations cannot clearly be distinguished. Therefore econometric analysis is needed to control for all these factors that have been found to be relevant. Furthermore, panel analysis helps in getting clearer insights into the direction of causality.

ECONOMETRIC RESULTS

In a first step, we run cross section regressions to estimate the number of declarations on a standard. We include the number of releases, amendments and standard pages as explanatory variables to capture the effect of standardization itself. We add dummy variables giving 1 if there is a pool or a consortium that can be linked to this particular standard. In order to control for truncation, we add the age of the standard as control variable. Furthermore, we control for SDO and ICS class effects (both statistically not significant). Our explained variable is count, so that we use a poisson estimator.

1: Cross section poisson estimation of patent declarations Observations: 505

Pseudo R2: 0.6439

Explanatory variable	Coefficient	Robust Standard error (z statistic)
Consortium	0.4105	0.2975 (1.38)
Pool	1.9543	0.2984 (6.55)
Releases	0.3908	0.2955 (1.32)
Amendments	0.0527	0.0213 (2.48)
Max. Number of pages	0.00069	0.00018 (3.79)
Age of the standard	0.0020	0.0015 (1.28)
SDO control	0.0588	0.0856 (0.69)
Class control	-0.0347	0.0245 (0.16)
Constant	0.1199	1.0144 (0.12)

The econometric results confirm our descriptive findings. Standard size, as measured by the number of pages, has a clear impact on the number of declared patents. Taking into account the effect of standard size, the number of amendments, but not the number of releases has a significant positive effect on the number of declarations. This could indicate that many amendments to a standard are made with the objective to include technology protected by patents.

The existence of a pool has a positive and very significant effect on the number of declared patents. The effect of the existence of a consortium is not significant. It is at this stage not possible to interpret these findings as indicating a causal relationship, since it may well be argued that causality can go in both directions. Especially pools are likely to be created for standards with a high number of essential patents. In order to investigate this issue, we reverse the supposed direction of causality of the analysis.

We run logistic regressions to explain the existence of a pool / consortium (results in annex). Only the existence of a consortium is a significant factor in explaining the existence of a pool. This strong link between consortium and pool was expected taken into account the strong correlation evidenced in the descriptive findings. This link could be interpreted as an indicator of the positive effect of consortia on creating consensus among patent holders involved in standardization. In explaining the existence of consortia, while number of declarations and standard characteristics are not significant, the number of declaring firms is a positive and significant factor. This could hint to the fact that consortia are created when the number of patent holders increases so that coordination

becomes difficult. Nevertheless these logistic regressions cannot provide a full theory of the creation of industry alliances such as pools or consortia. In order to explain the creation of patent pools, standardization consortia and other firm alliances around formal standard setting, future work steps will have to rely upon firm level data. For our purpose it is enough to state that uncertainty about the direction of causation makes further analyses necessary.

Another potential problem that could lead to a bias is that we do not directly observe the commercial value or the technological complexity of a standard. It is possible that these unobserved factors jointly drive the number of patent declarations, standard releases and amendments upwards and increase the likelihood that there will be informal consortia and patent pools. This would be one reason more why the positive and significant coefficients cannot be interpreted as indicating a causal relationship.

In order to deal with the problems of unobserved heterogeneity regarding variables such as commercial value and technological complexity, we use fixed effect panel analysis. We argue that these unobserved factors are to a sufficient amount fixed over the lifetime of a standard so that fixed effect regression will not be biased and coefficients can be safely interpreted.

Our explained variable is still the number of declarations on a standard, but this time the observation is a half-year time span for each standard. This means that we count the patents declared essential to a standard during this particular period. Our explanatory variables still include characteristics of the standardization process, such as the number of amendments or of releases in this particular period or the number of pages the standard had at this moment. To control for the usual timing of patent declarations with respect to standard age and releases, we introduce various age variables, such as the age of the standard (time since first release), the square of the age of the standard, and the time since the release of the latest standard version. Our main explanatory variables are dummies on the activity of consortia or pools, which give one if at this moment there was a pool or consortium active for this standard. We also include a "pool to be launched" variable, which gives one if a pool launch will take place in the 3 half-year periods to come. As control variables, we still use class and SDO controls, and we add a time control to exclude time fixed effects or truncation problems. To address the problem of truncation, we furthermore drop observations for 2009 and 2010 (but all results hold the same if we keep them). As we expect unobserved heterogeneity between the standards and our explained variable is count, we run fixed effect regression with a poisson estimator.

1: Panel fixed effect poisson estimation of patent declarations Observations: 6550
Number of groups: 350

Explanatory variable	Coefficient	Standard error (z statistic)
Consortium active	-0.2637	0.0379 (-6.95)
Pool active	2.1818	0.1592 (13.71)
Pool to be launched	1.1556	0.1673 (6.91)
Release	0.1130	0.0559 (2.02)
Number of amendments	-0.0128	0.0291 (-0.44)
Periods since last release	-0.0454	0.0075 (-6.10)
Number of pages	0.0013	0.0001 (12.82)
Age of the standard	3.7723	0.8572 (4.40)
Age of the standard squared	0.0001	0.0000 (13.12)
Calendar year	-0.1292	0.0281 (-4.59)
Class control	0.2245	0.0802 (2.80)
SDO control	7.2679	0.5903 (12.31)

We can infer from the results that consortia and pools have a very significant influence on the declaration patterns for formal standards. The activity of an informal consortium significantly reduces the number of declarations on the related standard, while pools significantly increase the number of declarations. The variables for standardization activity and the life time of the standard seem to capture very well the by now established link between standardization and declarations. Most coefficients are highly significant and all signs are as expected. The most interesting finding for the time span is that while declarations typically take place close to releases, the number of declarations increases with the age of the standard. This means that there are more new declarations triggered by later than by earlier standard versions.

Interpretation of these findings is now more straightforward. For a given standard, and controlling for the common timing of patent declarations, the time when a patent pool is active is associated with a very strong propensity to declare patents as essential. This finding confirms results in the literature (Baron & Delcamp, 2010) that patent pools increase incentives to file further patents on the technology included into a standard. As patent pools distribute royalty income proportionally to the number of patents, companies have obvious incentives to introduce as many patents as possible. We furthermore confirm theoretical results in the literature (Versaevel & Dequiedt, 2007) predicting a strong increase in patent files and declarations when a patent pool is about to be created.

The finding of a strong and significant negative effect of a consortium on the number of declared patents is new. We believe that this result provides further evidence for the role that informal consortia play in regulating firm strategies and in curbing non-cooperative behavior. As we control for standardization activity, the negative effect of consortia on patent declarations cannot be interpreted as a reduction in related innovation or intensity of innovation. We furthermore verify that the decrease in the number of patents declared essential does not go along with a decreasing number of firms declaring essential patents (results in Annex 3). It can therefore be ruled out that our finding of a negative effect of consortia on the number of patent declarations is an indicator of exclusionary effects.

Rather it seems that consortia reduce the propensity to declare many essential patents at given number of firms and given standardization activity. Massive filing and declaration of a high number of essential patents can be interpreted as the outcome of a non-cooperative equilibrium. Every firm files a high number of essential patents in order to obtain a significant share in the royalty incomes. As the competitors do the same, the relative shares remain the same, but the costs for patent applications and licensing transactions increase. Coordination mechanisms between standardization participants such as informal consortia seem to be at least partially effective in curbing this type of inefficient strategic interplay.

Some caveats are warranted for interpretation of our results. Even though fixed effect panel analysis should sufficiently take care of unobserved heterogeneity, potentially severe methodological issues may still affect our results. For instance we have to investigate whether our explanatory variables are exogenous. It can for instance be argued that pools are launched when a significant number of patent declarations is foreseeable. In this case once again uncertainty over the direction of causation will make straightforward interpretation of the results difficult. Furthermore, the explanatory variables could be influenced by the past outcomes of the explained variable. It is possible that the stock of patents already declared essential has an impact on the eventual standardization activity. In this case, the explanatory variables would not be independent of the error term. In spite of these limitations, we believe that our results are sufficiently robust and significant to support our conclusions.

RESEARCH OUTLOOK AND CONCLUSION

With the use of an exhaustive and comprehensive data set of formal standards that include IPR, our analysis is the first to evaluate the effects of informal industry consortia and patent pools on the interplay between patents and formal standards. The analysis is able to distinguish different factors that can trigger or inhibit a patent declaration and discusses the different influences. Our statistical results provide evidence that not only the standard size or the standardization process influences a patent declaration, but that pools and consortia have a significant impact.

Our results reveal the close link between standardization and declaration of essential patents, as evidences through the timing of patent declarations. Furthermore our calculations revealed a size effect, showing that a standard with a higher number of pages is likely to increase a higher number of patent declarations. A possible interpretation is that big standards affect a wider field of technology and have thus more essential patents included.

Less obvious seems the influence of patent pools and informal consortia on formal standards that include patents. Our findings on patent pools are conform with theoretical predictions and other empirical studies supporting the assumption that pools can induce companies to file more standard related patents. Yet, our results are even more precise, since our analysis controls for standardization activities.. The effect of a patent pool on filing of standard related patents thus also accrues when there is no additional activity in the respective standard. These findings indicate an opportunistic patent behavior. The increase in the number of patents induced by patent pools is unlikely to reflect an increase in innovation. Patents are more likely filed only to receive royalties in view of the existence of a patent pool.

The other external factor that influences a patent declaration is the existence of an informal consortium which accompanies formal standardization. In contrast to patent pools, consortia reduce the number of patent declarations. In time periods for which we can identify an informal consortium relating to a concrete formal standard, patent declarations are less frequent, controlling for the standardization activities and the existence of a pool. These findings are in line with the extant literature, where the role of informal consortia is mostly described to act as a technological selector. The decreased number of patent declarations could thus reflect a lesser degree of wasteful duplication of R&D efforts. However, our results could also indicate that informal consortia can function as an external forum to manage the questions of IPR and thus reduce non-cooperative patent strategies. This interpretation gains further support taking into consideration the positive effect of consortia on the likelihood that there will be a patent pool. Besides these relationships, consortia are more likely to accompany standards for which a high number of firms have declared

essential patents. The latter result indicates a need for an external coordination forum when the number of patent holders increases.

Taking all our results into account, we conclude that patent activity accompanying the standardization process is influenced by two factors: Patent pools create incentives for strategic patenting and informal consortia reduce such behavior. We conclude that consortia that have a connection to a formal standard organization pursue regulatory functions that can reduce costly patent inflation around technological standards. A cooperation of informal and formal standardization can thus be a solution to solve the problems of essential IPR upfront.

The effect of patent pools on essential patents can be discussed controversially. On the one hand researchers see the objective that a patent pool is usually created to reduce transaction cost and solve the licensing problem. Even if the number of essential patents increases, the pool can still reduce license fees and make licensees and consumers better off. But on the other hand our results confirm previous results that patent pools increase incentives for costly opportunistic patent behavior.

A future research topic is the inverse effects of our variables and especially the effects of patents on standardization. Building upon our data panel we are able to test the impacts of essential patents on standardization activities such as releases or amendments. In addition we will also investigate the direct contribution of informal consortia and patent pools to the standardization process.

REFERENCES

Baron, J., Delcamp, H. (2010): *Strategic inputs into patent pools*, Cerna working paper.

Bekkers, R., Duysters G., Verspagen B. (2001): *Intellectual property rights, strategic technology agreements and market structure The case of GSM*, Research Policy 31 (2002) 1141–1161.

Besen S. M., Levinson R. J. (2009): *Standards, Intellectual Property Disclosure, and Patent Royalties after Rambus*, North Carolina Journal of Law & Technology Volume 10, Issue 2: SPRING 2009.

Blind, K., Thumm, N. (2004): *Interrelation between patenting and standardization strategies: empirical evidence and policy implications*, Research Policy 33 (2004) 1583–1598.

Blind K., Edler J., Frietsch R., Schmoch U. (2006): *Motives to patent: Empirical evidence from Germany*, Research Policy 35 (2006) 655–672.

Blind, K., Gauch, S. (2008): *Trends in ICT standards: The relationship between European standardization bodies and standards consortia*, Telecommunications Policy 32 (2008) 503–513.

Cargill, C. (2002). *Intellectual Property Rights and Standards Setting Organizations: An Overview of failed evolution*, A Report Issued By the U.S. Department of Justice and the Federal Trade Commission, March 2002.

Delcamp, H. (2010): *Essential patents in pools: Is value intrinsic or induced?*, Cerna working paper.

Devlin, A. (2009): *Standard-Setting and the Failure of Price Competition,* working paper.

Gilbert, R. (2009): *Ties that Bind: Policies to Promote (Good) Patent Pools*, working paper.

Heller M. A., Eisenberg R. S. (1998): *Can Patents Deter Innovation? The Anticommons in Biomedical Reserach*, 280, Science, 698-701.

Hovenkamp, H. J. (2008): *Patent Continuations, Patent Deception, and Standard Setting: the Rambus and Broadcom decisions*, working paper.

Iversen, J. E. (2002): *Standardization and Intellectual Property Rights: ETSI's controversial search for new IPR-procedures*, SIIT proceedings paper.

ISO, IEC (2009): ISO/IEC directives Part1, Seventh edition, 2009.

Koehler, F., Blind K., Thumm, N. (2009*): Keep 'Em In, Make 'Em Fit - An Analysis of Patent Filing Behaviour for Essential Patents in Standards*, Working Paper Oct 2009.

Lamley M. A. (2002): *Intellectual Property Rights and Standard Setting Organizations*, Public Law and Legal Theory Research Paper No. 84.

Lampe, R., Moser, P. (2009): *Do Patent Pools Encourage Innovation? Evidence from the 19th century Sewing Machine Industry*, working paper.

Layne-Farrar A. (2008): *Innovative or Indefensible? An Empirical Assessment of Patenting within Standard Setting*, working paper.

Layne-Farrar A., Lerner J. (2008): *To Join or not to Join: Examining Patent Pool Participation and Rent Sharing Rules*, working paper.

Layne-Farrar, A. (2010): *Is EX ANTE the Norm? An Empirical Look at IPR Disclosure Timing within Standard Setting*, working paper.

Leiponen A. E. (2008): *Competing Through Cooperation: The Organization of Standard Setting in Wireless Telecommunications*, Management Science Vol. 54, No. 11, November 2008, pp. 1904–1919.

Lerne, J. and Tirole, J. (2004): *Efficient Patent Pools*, American Economic Review, vol. 94(3)

Parchomovsky, G. and Wagner, R. (2005) : *Patent Portfolios*, University of Pennsylvania Law Review, vol. 154(1)

Pohlmann, T. (2010): *Attributes and Dynamic Development Phases of Informal ICT Standards Consortia,* working paper.

Quint, D. (2006): *Economics of Patent Pools when Some (but not all) Patents are Essential*, SIEPR Discussion Paper

Rysman M., Simcoe T. (2008), "*Patents and the Performance of Voluntary Standard Setting Organizations*", Management Science, Vol. 54, N 11, pp. 1920-1934

Rysman, M., Simcoe, T. (2007): *The Performance of Standard Setting Organizations: Using Patent Data for Evaluation*, Journal of IT Standards & Standardization Research, 5(1), 25-40, January-June 2007 25.

Shurmer M., Lea G. (1995): *Telecommunication Standardization and intellectual property rights: A fundamental dilemma?*, Standard review Vol. 3, No. 2 June/1995.

Updegrove, A. (2008). *The Essential Guide to Standards*, Handbook of Consortium Info in: [http://www.consortiuminfo.org].

Versaevel, B., Dequiedt, V. (2007): Patent Pools and the Dynamic Incentives to R&D, working paper.

Annex 1: List of informal consortia which can be matched to a formal standard that includes essential patents:

Gigabit Ethernet Alliance (GEA)
100VG-Anylan Forum
1355 Association
DLNA - Digital Living Network Alliance
DVD Forum
ECMA
ISMA – Internet Streaming Media Alliance
MEF - Metro Ethernet Forum
1394TA - The 1394 High Performance Serial Bus Trade Association
AIM - Association for Automatic Identification and Mobility
FCIA - Fibre Channel Industry Association
IVI Foundation (Interchangeable Virtual Instruments)
OIF – Optical Internetworking Forum
RapidIO Trade Association
TAHI - The Application Home Initiative
Wi-Fi Alliance
WIMAX Forum – Worldwide Microwave Interoperability Forum
WiMedia Alliance
HGI - Home Gateway Initiative
AUTOSAR - Automotive Open System Architecture Partnership
OCP-IP - Open Core Protocol International Partnership
ACCELLERA
BPMI – Business Process Management Initiative
GS1 – (Formerly EAN)
ASTM International
DISA - Data Interchange Standards Association
MPEG Industry Forum
INCITS - National Committee for Information Technology Standards
Cablelab – Cable Laboratories
NFC Forum - Near Field Communication Forum
ewc
ODVA – Open DeviceNet Vendor Association, Inc
IMTC – The International Multimedia Teleconferencing Consortium
OMG – Object Management Group
PICMG – PCI Industrial Computer Manufacturers Group
TOG – The Open Group
IETF – Internet Engineering Task Force
UPnP – Universal Plug and Play Forum
Bluetooth - Bluetooth Consortium
EUROSMART – European Smart Card Industry Association
HAVi – Home Audio Video Interoperability
HomePlug – HomePlug Powerling Alliance
ZigBee - The ZigBee Alliance
PWG - Printer Working Group
DMPF - The Digital Media Project

Annex 2: Logistic regressions to explain pool and consortia occurrence

1: Cross section logistic regression of Pool existence Observations: 505

Pseudo R2: 0.6202

Explanatory variable	Coefficient	Robust Standard error (z statistic)
Consortium	3.09024***	.7255506 (4.26)
Disclosure	.0838272	.0601906 (1.39)
Disclosure Square	-.0000989	.0000765 (-1.29)
Releases	-.0216049	.2127078 (-0.10)
Amendments	.0408008	.0719585 (0.57)
Max. Number of pages	-.0031472	.0042315 (-0.74)
Age of the standard	-.0088449	.0076133 (-1.16)
SSO control	3.19976	1.678314 (1.91)
Class control	.8939068	2.156379 (0.41)
Constant	-3.052229	3.049806 (-1.00)

*Regressions with robust standard errors. Legend: * p<0.05; ** p<0.01; *** p<0.001.*

2: Cross section logistic regression of Consortium existenceObservations: 505

Pseudo R2: 0.4746

Explanatory variable	Coefficient	Robust Standard error (z statistic)
Disclosing Firms	.0830314**	.0375539 (2.21)
Disclosure	.0250553	.0230618 (1.09)
Disclosure Square	-.0000364	.0000339 (-1.07)
Releases	.2246963	.1091483 (1.99)
Amendments	.0618078	.1041291 (0.59)
Max. Number of pages	.0014073	.0013853 (1.02)
Age of the standard	.0007059	.0034032 (0.21)
SSO control	2.945205	.3682875 (8.00)
Class control	-.0216145	.7564973 (-0.03)
Constant	-3.966872	1.881635 (-2.11)

*Regressions with robust standard errors. Legend: * p<0.05; ** p<0.01; *** p<0.001.*

Annex 3: Fixed effect Poisson estimation of the effect of consortia on the number of declaring firms

Fixed effect Poisson estimation of the number of new declaring firms

Number of observations: 7296

Number of groups: 356

Explanatory variable	Coefficient	Standard error (z statistic)
Consortium active	-.0563868	.067236 (0.40)
Pool active	1.286396***	.2785981 (4.62)
Pool to be launched	-.0159524	.3317361 (-0.05)
Release	.1942518**	.0821732 (2.36)
Number of amendments	.0466482	.0630234 (0.74)
Periods since last release	-.0396056***	.0108169 (-3.66)
Number of pages	-.0003027	.0002831 (-1.07)
Age of the standard	-.1394367***	.0152309 (-9.15)
Age of the standard squared	.0001121	.000131 (8.53)

SDO control dummies not reported.
*Legend: * p<0.05; ** p<0.01; *** p<0.001.*